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HOST SPECIFICITY STUDIES OF *STOLAS FUSCATA* (KLUG) (COLEOPTERA:CHRYSOMELIDAE) FOR THE BIOLOGICAL CONTROL OF *BACCHARIS SALICIFOLIA* (R. & P.) PERS. (ASTERACEAE)

PAUL E. BOLDT

Grassland, Soil and Water Research Laboratory, Agricultural Research Service, USDA, 808 East Blackland Road, Temple, Texas 76502.

Abstract.—The leaf feeder *Stolas* (*Anacassis*) *fuscata* (Klug), from Argentina, was studied in quarantine as a potential biological control candidate of seepwillow, *Baccharis salicifolia* (R.&P.) Pers. in the United States. No-choice tests were conducted with first-instar larvae on 34 plant species in 7 tribes of Asteraceae and 3 additional families. Pupation occurred primarily on *B. salicifolia* and to a lesser degree on *Gymnosperma glutinosum* (Spreng.) Less. and *Aster subulatus* Michx. No-choice tests were also conducted with adults on 23 plant species representing 5 tribes and 12 genera of Asteraceae. Leaf consumption and longevity were greatest on *B. salicifolia* and *A. subulatus*, and oviposition occurred only on these species. *Stolas fuscata* apparently has a high degree of host specificity. This insect does not attack any economically important plant, and the risk of it feeding on any species other than *B. salicifolia* is small.

Key Words: Insecta, Coleoptera, Chrysomelidae, *Stolas*, Asteraceae, *Baccharis*, seepwillow, host specificity, biological control

Seepwillow, *Baccharis salicifolia* (R.&P.) Pers. (formerly = *glutinosa* Pers.) (Asteraceae) is an undesirable woody phreatophyte, 2 to 3 m in height, and has few, if any, economic benefits. This shrub contributes little to stream bank stability. Dense thickets of seepwillow impede water flow and contribute to channel migration, overflow and increased sedimentation (Horton 1959, Parker 1972). Seepwillow has little or no value to wildlife except for the cover it provides and is not listed as a food source by Martin et al. (1951) for any wildlife species in the United States. No birds are closely associated with this shrub (Engel-Wilson and Ohmart 1978, Anderson and Ohmart 1984).

Stolas (*Anacassis*) *fuscata* (Klug) is a potential biological control agent for seepwillow. This beetle, a leaf feeder in both larval and adult stages, occurs only in Argentina, Brazil, Paraguay (Blackwelder 1946) and Uruguay (Guido et al. 1956). Originally described in the genus *Cassida*, *fuscata* was later placed in *Anacassis* by Spaeth (1913). Most recently *Anacassis* has been recognized as a subgenus of the large neotropical genus *Stolas* (Hincks 1952). This status is maintained in Seeno and Wilcox (1982) and followed in the present paper. Buzzi (1975) and McFadyen (1987), working in South America, continue to recognize *Anacassis* as a valid genus separate from *Stolas*.

I conducted host specificity tests on *S. fuscata* from Argentina as part of a project to study the biological control of seepwillow. Tests by McFadyen (1987) indicated that both *Stolas fuscata fuscata* from Brazil and *S. fuscata unicolor* (Burmeister) from Argentina feed only on 3 species of *Baccharis* and the related *Baccharidastium triplenerve* (Lessing) Cabrera.

The populations of *S. fuscata* used in these tests are probably identical to *S. fuscata unicolor* in Argentina and very similar to *S. fuscata fuscata* in Brazil. The male and female genitalia of both subspecies were compared by H. Cordo (pers. comm.). He found no consistent differences in structure. My specimens were identified as *S. fuscata* by both Z. Buzzi (pers. comm.) and R. E. White (pers. comm.), but neither identified a subspecies. Possible differences between subspecies in host feeding were reported by McFadyen (1987). In 1979 several thousand adults of *S. Fuscata fuscata* were released in Queensland, Australia, for the biological control of *B. halimifolia*. They apparently fed on the plant but did not become established in the field (McFadyen 1987). *Stolas fuscata unicolor* from Argentina was also brought into Queensland but did not survive in quarantine. The subspecies name is not used in this manuscript for lack of confirmation of its validity. Although physiological differences may exist between the populations, morphological differences are not sufficiently unique to identify subspecies.

Materials and Methods

Larvae and adults of *S. fuscata* were collected on *Baccharis salicifolia* by H. Cordo near Arroyito, Neuquen; Realico, La Pampa; San Rafael, Mendoza; and Pedro Luro, Buenos Aires, Argentina, during the months of February and March from 1985 to 1987 and air-freighted to the Insect Quarantine Facility, USDA-ARS, Temple, Texas. A colony of this insect was maintained in quarantine on excised leaves of potted *B. salicifolia* or leaves periodically collected in the field near Laredo, Texas.

All experiments were in the quarantine facility at Temple, Texas. The room was held at temperatures of 22 to 26° C, relative humidity of 40 to 60% and a 12:12 h L:D photoperiod under artificial light. Leaf consumption was determined by placing a 1 mm plastic grid over the leaf and counting the squares or with a Li-Cor Model Li 3000 leaf area meter before and after feeding. Because an entire experiment could not be done at the same time, there was a control treatment of seepwillow each time any plant was tested. Plants used in the tests were collected in Texas and held out-of-doors except for *Baccharis pilularis* DC., which was collected in California; those plants selected were species closely related to seepwillow or economically important. Plants were allowed to flower when possible, and voucher specimens were deposited in the permanent collection of the Grassland, Soil and Water Research Laboratory, Temple, Texas. Insect specimens were deposited in the National Museum of Natural History, Washington, DC.

Larva host tests.—No-choice tests were conducted by holding a single unfed, 0- to 48-hour old larva in a small (9.0 cm diam.) petri dish on freshly excised leaves of a selected plant species until death or pupation occurred. Leaves were replaced every second or third day. The amount of leaf consumed, stage of development and number of days survived were recorded. A replication consisted of 10 larvae per plant species. Each of the 34 plant species was replicated at least 3 times.

Adult host tests.—In the first of two adult no-choice tests, a single unsexed, unfed, 3- to 5-day-old adult was held in a small petri dish on freshly excised leaves of each test plant. Leaves were replaced every second or third day, and the amount of leaf consumed was recorded until death occurred. A replication consisted of 1 adult per plant species. Each of the 15 plant species was replicated 10 times.

The second adult no-choice test was similar except that 15, 2- to 6-day-old adults were held on each plant species in a large

Table 1. Average feeding and longevity of larvae of *S. fuscata* on leaves of various plants.

Plant Species	No. of Larvae	Leaf Consumption (cm^2)[a]	Longevity Time (days)[a]
ASTERACEAE			
Astereae			
Baccharis salicifolia (R. & P.) Pers.	110	52.6 ± 12.4	16.3 ± 2.3
Aster novae-angliae L.	30	0.1 ± 0.1	4.0 ± 0.3
A. subulatus Michx.	40	10.7 ± 4.2	9.0 ± 2.4
A. sp. (form Michaelmas)	30	0	4.0 ± 0.9
Baccharis bigelovii Gray	40	0.6 ± 0.7	5.3 ± 2.5
B. brachyphylla Gray	40	0	3.3 ± 1.0
B. halimifolia L.	40	0.6 ± 0.4	5.5 ± 2.0
B. neglecta Britt.	40	5.5 ± 8.8	7.1 ± 2.4
B. pilularis DC.	30	0.3 ± 0.2	5.3 ± 1.9
B. pteronioides DC.	30	0.1 ± 0.1	3.4 ± 0.6
B. sarothroides Gray	30	0	3.2 ± 0.7
Chrysothamnus nauseosus (Pall.) Britt.	30	0.1 ± 0.1	4.2 ± 1.4
Ericameria austrotexana M. C. Johnst.	30	0	3.7 ± 0.4
Grindelia lanceolata Nutt.	30	2.4 ± 3.3	7.1 ± 4.2
Gutierrezia microcephala (DC.) Gray	30	0.2 ± 0.4	5.2 ± 3.1
Gymnosperma glutinosum (Spreng.) Less.	50	0.4 ± 15.9	8.9 ± 7.5
Haplopappus tenuisectus (Greene) Blake	30	0	3.4 ± 1.3
Isocoma coronopifolia (Gray) Greene	30	0	3.9 ± 0.5
Solidago altissima L.	30	0.5 ± 0.9	4.3 ± 1.6
Eupatorieae			
Brickellia laciniata Gray	30	0.1 ± 0.1	2.4 ± 2.0
Heliantheae			
Helianthus annuus L.	40	0.1 ± 0.1	2.9 ± 0.4
Rudbeckia hirta L. (form "gloriosa")	30	0	2.2 ± 0.2
Viguiera dentata (Cav.) Spreng.	30	0	3.5 ± 0.6
Zinnia acerosa (DC.) Gray	30	0.1 ± 0.1	3.7 ± 0.5
Helenieae			
Callistephus chinensis (L) Nees	30	0.2 ± 0.4	2.3 ± 2.2
Gaillardia pulchella Foug. (form "grandiflora")	40	0	3.2 ± 0.7
Tagetes patula L.	40	0	3.1 ± 0.7
Anthemideae			
Artemisia filifolia Torr.	30	0	3.0 ± 0.9
Chrysanthemum cinerariifolium Vis.	30	0	3.2 ± 0.2
C. morifolium Ramat.	30	0.2 ± 0.3	2.6 ± 0.5
Cynareae			
Carduus macrocephalus Desfontaines	30	0	2.9 ± 0.7
Cichorieae			
Lactuca sativa L.	30	0	3.0 ± 0.4
ASCLEPIADACEAE			
Asclepias viridis Walt.	30	0	2.7 ± 1.2
GRAMINAE			
Zea mays L.	30	0	2.7 ± 0.3

[a] Mean ± standard deviation.

petri dish (14.1 cm diam). Leaf consumption, survival time, the number of eggs laid, and percent hatched were recorded. Each of the 10 plant species was replicated 3 times except for *Isocoma wrightii* (Gray) Rydb. which was replicated twice and seepwillow which was replicated 5 times. All adults were dissected after death to determine sex.

Table 2. Percentage of larvae of *S. fuscata* surviving on various test plants and number of days to pupation.

Test Plant	No. of Larvae	Larval survival: 5th Instar No.	%	Pupae No.	%	Days to Pupation[a]
Baccharis salicifolia	110	89	80.9	83	75.5	19.1 ± 3.2
Aster subulatus	40	4	10.0	2	5.0	20.3 ± 2.75
Baccharis neglecta	40	2	5.0	0	—	0
B. halimifolia	40	1	2.5	0	—	0
Callistephus chinensis	30	1	3.3	0	—	0
Gymnosperma glutinosum	50	8	16.0	6	12.0	27.7 ± 1.6

[a] Mean ± standard deviation.

Results

Larva hosts tests.—Significant feeding and survival occurred on several species in the tribe Astereae (Asteraceae) and one species, *Callistephus chinensis* (L.) Nees, in the tribe Helenieae (Table 1). More feeding occurred on seepwillow than on either *Gymnosperma glutinosum* (Spreng.) Less. or *Aster subulatus* Michx.; and only minor feeding occurred on *Baccharis neglecta* Britt. and *Gutierrezia microcephala* (DC.) Gray. Few larvae on non-host plants, including the 5 other species of *Baccharis,* survived beyond the second instar, although some larvae survived without feeding for up to 4 days.

Neonate larvae fed and developed to the fifth instar only on the plants listed in Table 2. Normal pupation occurred for 75.5% of the larvae restricted to seepwillow but only for 12.0% of the larvae on *G. glutinosum* and 5.0% of the larvae on *A. subulatus.* Larvae on other species died without pupating.

Adult host tests.—In the first adult no-choice test, feeding occurred primarily on a few plants in the tribe Astereae. Adults on seepwillow consumed over 9 times more foliage than those on *Isocoma coronopifolia* (Gray) Greene, the next most fed on plant (Table 3). Mean longevity on seepwillow was 26.1 days, but it was longer on *I. coronopifolia, G. glutinosum* and *G. microcephala.* Survival on *Antennaria fallax* Greene was nearly as long as on seepwillow although the adults apparently did not feed.

In the second adult no-choice test, significantly greater longevity, feeding and oviposition were recorded on seepwillow than on any other species in the test (Table 4). The 39 females on seepwillow lived 34.3 days longer than the 19 females on *Aster subulatus* Michx. and laid over four times the number of eggs per female. The mean percent egg hatch was 79.4% on seepwillow as compared with 32.5% on *A. subulatus.* No eggs were laid on any other species.

Discussion

Stolas fuscata appears to be a suitable biological control agent for seepwillow. Hosts of *S. fuscata* are limited to a few plants in the subtribe Baccharidinarum, as shown by larval and adult multiple-choice tests on 52 plant species in 25 families in both Argentina and Brazil (McFadyen 1987). My tests of larvae on 34 additional plants and adults on 23 plants in no-choice tests also indicate a high probability that if *S. fuscata* were released in the United States it would establish only on seepwillow.

The risk that *S. fuscata* might survive on the perennial shrub *G. glutinosum* is minimal. No eggs were laid, adults fed poorly and only 12.5% of the larvae pupated on *G. glutinosum.* This plant is more closely related to the genus *Gutierrezia* than to *Baccharis* and has few recorded benefits (Martinez 1959).

Eggs were laid by *S. fuscata* only on seepwillow and *A. subulatus.* Calculations from these tests, conducted under restrictions of

Table 3. Feeding and longevity of adults of *S. fuscata* on leaves of various plants.

Plant Species	No. of Adults	Amount Consumed (cm²)[a]	Amount Consumed/Day (cm²)[a]	Longevity (days)[a]
ASTERACEAE				
Astereae				
Baccharis salicifolia	10	95.1 ± 73.9	33.0 ± 19.0	26.1 ± 17.9
B. neglecta Britt.	10	3.2 ± 6.6	0.2 ± 4.0	17.3 ± 10.6
B. halimifolia L.	10	0.1 ± 0.2	—[b]	14.9 ± 12.1
B. pilularis DC.	10	1.1 ± 2.2	0.1 ± 1.0	12.8 ± 6.5
Ericameria austrotexana M. C. Johnst.	10	0	0	20.5 ± 14.5
Grindelia squarrosa (Pursh) Dun.	10	3.0 ± 7.9	0.1 ± 1.0	23.9 ± 15.9
Gutierrezia microcephala (DC) Gray	10	1.1 ± 1.2	0.1 ± 0.0	32.6 ± 17.7
Gymnosperma glutinosum (Spreng.) Less.	10	5.5 ± 10.3	0.1 ± 2.0	31.1 ± 21.1
Isocoma coronopifolia (Gray) Greene	10	10.2 ± 16.6	0.2 ± 0.3	38.2 ± 19.6
Solidago altissima L.	10	0	—[b]	16.5 ± 14.8
Anthemideae				
Artemisia filifolia Torr.	10	0.1 ± 2.0	—[b]	16.0 ± 13.0
Chrysanthemum morifolium Ramat.	10	1.0 ± 2.0	—[b]	12.7 ± 12.5
Cynareae				
Centaurea macrocephala Pushk.	10	0.3 ± 0.5	—[b]	19.9 ± 14.6
Helenieae				
Gaillardia pulchella Foug.	10	0	0	17.5 ± 12.3
Inuleae				
Antennaria fallax Greene	10	0	0	21.0 ± 16.9

[a] Mean ± standard deviation.
[b] Amount consumed is less than 0.01 cm/day.

the quarantine, show that a hypothetical female fed leaves of seepwillow will lay 325 eggs which will result in 99.7 first generation females (Table 5). However, one female and offspring fed only on *A. subulatus* will produce less than 1 female. This difference is the result of increased oviposition on seepwillow and high mortality of eggs and larvae on *A. subulatus*. Only 5 % of the neonate larvae on *A. subulatus* survived to the pupal stage.

Occasional feeding on *A. subulatus*, if it does occur, should not be considered detrimental because this species is an annual

Table 4. Longevity and oviposition of *S. fuscata* on various species of Astereae in no-choice tests.

	No. of adults	Longevity[a] Male	Longevity[a] Female	Leaf Consumption per adult (cm²)[a]	Eggs per Female[a]
Baccharis salicifolia	75	56.5 ± 30.1	69.9 ± 38.2	59.4 ± 17.6	325.2 ± 163.6
Aster subulatus Michx.	45	44.9 ± 21.7	35.6 ± 22.8	37.7 ± 8.7	72.0 ± 64.8
A. ericoides L.	45	9.2 ± 5.2	13.4 ± 5.9	0.4 ± 0.4	0
A. novae-angliae	45	9.1 ± 3.4	9.5 ± 3.8	0.5 ± 0.5	0
A. praealtus Poir.	45	20.3 ± 13.0	29.7 ± 18.9	12.4 ± 3.5	0
A. spinosus Benth.	45	8.5 ± 1.5	9.1 ± 1.5	0.1 ± 0.1	0
A. texanus Burgess	45	7.6 ± 2.6	13.4 ± 8.6	0.5 ± 0.7	0
Ericameria laricifolia (Gray) Shinners	45	10.7 ± 6.3	14.8 ± 15.7	0.1 ± 0.1	0
Gymnosperma glutinosum (Spreng.) Less.	45	13.0 ± 8.3	9.9 ± 5.2	0.2 ± 0.3	0
Isocoma wrightii (Gray) Rydb.	30	5.7 ± 1.6	5.6 ± 1.2	0.1 ± 0.1	0

[a] Means ± standard deviation.

Table 5. Survival of *S. fuscata* when parent and offspring are fed *B. salicifolia* or *A. subulatus*.

Stage	*B salicifolia*			*A subulatus*		
	Sample size	No. entering stage	% survival	Sample size	No. entering stage	% survival
Egg	39	325	79.4	19	72	32.5
Larva	110	258	75.5	40	23.4	5.0
Pupa	83	194.8	—	2	1.17	—
No. of females (51.2%)		99.7			0.6	

native weed with no economic value. It is abundant in ditches, margins of ponds, streams, and poorly drained areas of the United States from North Carolina to California (Correll and Johnston 1979). It is widespread in Central America and is considered a weed in Australia and western Asia (Faust and Strang 1983).

There are no *Baccharis* species listed in the Federal Register of 1986 as being threatened or endangered (Anon. 1986).

Biological control of seepwillow offers a relatively inexpensive, environmentally-compatible alternative to both mechanical and chemical control. A comparison of the climate where *S. fuscata* occurs in Argentina with the climate associated with the geographical distribution of seepwillow in North America suggests that the insect may adapt to the arid southwestern United States and probably move into northern Mexico (Walter et al. 1975). The release of *S. fuscata* would represent one of the first deliberate attempts to control a native plant with an exotic insect in the continental United States. The expected result is a reduction in the density of this plant but not its elimination (Johnson 1984, Harris 1986).

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